DOCUMENT RESUME

ED 242 287 IR 010 996

AUTHOR Barker, Philip G.
TITLE Computer Control of a Random Access Slide Projector.
PUB DATE 82
NOTE 12p.
PUB TYPE Computer Programs (101) -- Reports - Descriptive (141)
JOURNAL CIT Microprocessing and Microprogramming; v10 p261-271 1982

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Assisted Instruction; Display Aids; *Display Systems; Information Processing; Input Output Devices; *Microcomputers; Programing; *Projection Equipment; *Slides
IDENTIFIERS *Automatic Control Systems; Random Access

ABSTRACT

A description of a simple interface to enable the interconnection of a random access slide projector and a microcomputer is provided, as well as summaries of the role of slide images as a means of implementing graphic communication and the new activity in graphics as an area of information processing. The microcomputer interface is then detailed, including limitations of the technique and suggestions for improvement. An analysis of applications of the interface focuses on multimedia computer assisted instruction systems, implementing automatic slide display systems, and implementing graphic interfaces to information systems. Figures illustrate the computer controlled slide projector, the function of a manual slide selector, design of the interface, switching element circuit details, and memory mapped random access slide projectors. Tables show an example of an interface control program written in BASIC and present a program for automatic slide projection. Fifteen references are listed. (LMM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED242287

EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

North-Holland Publishing Company
Microprocessing and Microprogramming 10 (1982) 261–271

Computer Control of a Random Access Slide Projector

Philip G. Barker
Department of Computer Science, Teesside Polytechnic, County Cleveland, United Kingdom

The role of slide images as a means of implementing graphic communication is summarised. A technique for the microcomputer control of a random access slide projector is then outlined. The design and implementation of a general purpose interface that facilitates this operation is described. The limitations of the interface are indicated and suggestions for improvements are discussed. Some examples of the use of the system in several application areas are then presented.

Keywords: Graphic display, automatic control, slide projector, random access, image projection, interface, computer control, slide images.

1. Introduction

Information may take a variety of different forms: numeric, textual and pictorial are three common examples. Techniques for numeric information processing via computers are now well established. Consequently, over the last decade, much emphasis has been given to the problem of handling textual material. Advances in the power of both microcomputers and data storage devices have been combined to produce a multitude of document, text and word processing systems. Like numeric computation text handling is now a standard facility on most micros.

Presently, there is considerable activity in a third area of information processing - graphics. Graphic information may take many different forms. Broadly, these fall into two fundamental categories - based upon the use of either static or animated images. Both forms may originate from two possible sources. These may either be generated by a computer program or be captured by some form of camera. Images of either sort may be stored on an appropriate storage medium. Later, they may be retrieved for display via a suitable presentation system. Currently, there is much interest in computer systems that are able to process pictorial information - either internally (as in robot vision systems) or externally (as in image retrieval applications).

Graphic images may be stored externally on many different kinds of storage device - for example slides, cinefilm, videotape and optical disk. The first of these offers an easy, inexpensive way of storing static graphical images. The latter three media provide increasingly sophisticated image storage techniques that offer the possibility of handling both static and dynamically changing scenes. Combined with appropriate computer technology these external image storage devices have a variety of uses. Undoubtedly, slide projection equipment is the least costly and probably the most readily available. This paper describes the use of a microcomputer for controlling the display of images retrieved from one or more random access slide projectors.

2. Use of Slide Projectors

Pictorial communication through the medium of slides is a powerful means of disseminating information. Because of the large amount of highly resolved detail that can be contained in a picture, this type of message channel has a high bandwidth for information transfer. For this reason slides are often used to supplement lectures on scientific and technical topics. Other information dissemination activities such as computer aided learning and computer based aiding systems also frequently employ slide presentation techniques in order to supplement material presented via a VDU screen. In addition, slides are often widely used for advertising and sales promotion - especially where auto-

IR010996

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
P.G. Barker

U.S. DEPARTMENT OF EDUCATION

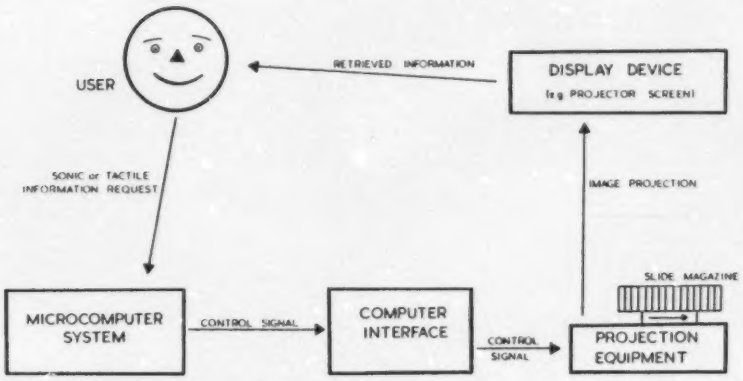


Fig. 1. Computer Controlled Slide Projection.

mated display systems can be set up and left running without the need for a human operator.

Computer based training and aiding systems that involve the use of slide images will require a facility that enables the interconnection of their embedded microcomputer to the external picture projection equipment. In order to achieve this, some form of hardware/software interface is usually required – as depicted in Fig. 1. Microcomputer peripherals are normally inter-linked by means of one or more of the internationally accepted interfacing standards: RS-232-C, IEEE-488, CAMAC, S-100 and so on. Unfortunately, there are no commonly agreed upon standards for the interfacing of peripherals such as slide projectors, video-tapes or video-disk systems. In view of this, arbitrary non-standard interfaces often have to be used. The basic function of the interface is to convert control signals produced by the computer into a form that are acceptable to and which can be handled by the slide projector. The detailed design of the interface will obviously depend upon the nature of both the microsystem and the slide projector(s) to which it is to be interfaced.

Many different types of projector are available [1]. Some operate in a strictly sequential fashion while others operate in both sequential and random access modes. A sequential projector permits only serial access to images. Thus, in a sequence of slides numbered 1 through 80, image 64 cannot be accessed until after image 63 has been presented. In a random access projector, however, this restriction does not hold – slides can be accessed in any order. The Kodak Carousel S-RA2000 projector [2] is a typical example of such a device having a capacity for 80 slides with an access time of between 1.5 and 5 s depending upon the position of the storage carousel when a request is made.

3. The Microcomputer Interface

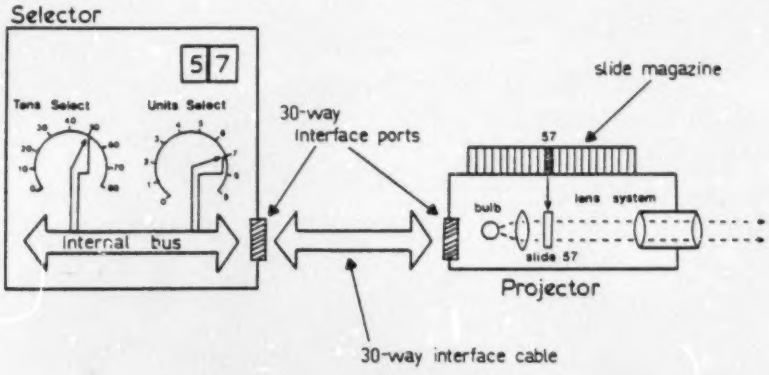
When used manually the projector may be driven by either a keyboard controller (based upon the use of a simple decimal numeric keypad) or a rotary control unit (that incorporates two thumb wheel switches). Both of these permit the user to enter a two digit code N ($0 \leq N \leq 80$) that specifies which of the 80 slides in the storage carousel is to be selected next. The value zero causes the slide magazine to rotate to the start position for unloading or initialisation of a retrieval sequence. Within the allowed range of integers there are no restrictions on the choice of N. Thus, the sequence (26, 07, 42) would cause slide 26 to be projected followed by slide 7 and then slide 42. The purpose of the computer interface is to enable the computer, under program control, to determine the sequence in which slides are to be presented. In order to perform its function the interface emulates the characteristics of the keyboard selectors mentioned above. Thus, in response to the control signals passed to it via the output port connections of a microcomputer the interface must

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

generate switching connections similar to those produced by the keyboard selector. In all of the work that is described here, a Commodore PET desktop computer [3] was used to control the interface. However, any other microcomputer having a compatible 8 bit output port would be capable of driving the interface.

Logically, the two manual slide selectors (keypad and rotary switch) perform the same function as would be performed by two 10-way switches connected in such a way as to enable the generation of a two digit decimal number. One of the switches would be used for the selection of a tens-digit (in the range 0 through 8) while the other would specify the corresponding units-digit (in the range 0 through 9). Such an arrangement of switches is illustrated schematically in the diagram presented in Fig. 2. This shows the switch settings that would be required for the selection of slide number 57 – as is indicated by the multi-segment LED displays located at the top right-hand corner of the selector device. Internally, the switches are connected by a suitable bus system that terminates externally in a 30-way surface mounted interface port. There is a matching port mounted on the random access slide projector. The two are interconnected by means of a 30-way interface cable. The pins on the 30-way plugs, and the corresponding socket locations are configured in the form of a 10×3 matrix. Each matrix position is labelled with a code consisting of a digit (in the range 0 through 9) that represents its row position and an alphabetic character (a, b or c) that specifies its column position within the matrix. The code enables interface connections to be uniquely specified and identified.

When a slide is selected by means of the selector,



Connections for switches other than 50 and 7 have been omitted for clarity

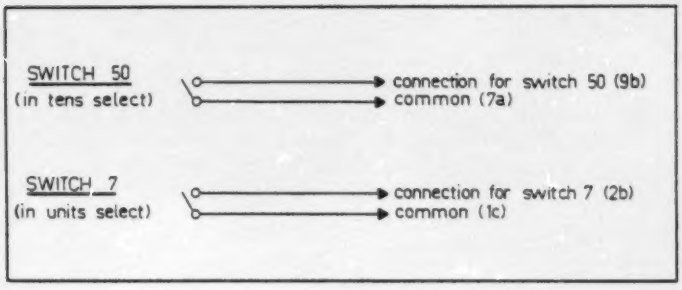


Fig. 2. Function of a Manual Slide Selector.

the internal mechanisms that are initiated may be likened to the closing of two separate switches – as shown in the lower part of Fig. 2. The switch connections are labelled in accordance with their correct interface designations. Thus, selection of slide 57 corresponds to making connections between points 9b and 7a for the tens digit and points 2b and 1c for the units digit. Once the connections are made an electronic balancing circuit within tne projector causes smooth automatic rotation of the slide carousel until the segment holding slide 57 is positioned above the entry port of the projection mechanism. Rotation then stops, the slide is inserted (gravity feed) and the image projected. The action of the selector switches illustrated in Fig. 2 can easily be reproduced by appropriately designed switching arrays. This is the basic principle underlying the design of the computer interface which uses two arrays of electronic reed relays each controlled by signals from the computer system.

In order to emulate the action of the keypad (or thumb-wheel) selector the 8-bit parallel input to the interface (output from the computer) is treated as two 4-bit binary coded decimal (BCD) numbers. The interface is designed in such a way that the leftmost four bits represent the tens digit of the slide number wh.ile the rightmost 4 bits represent the units digit. Each of these groups of four binary coded digits is fed to a SN74145N BCD to decimal

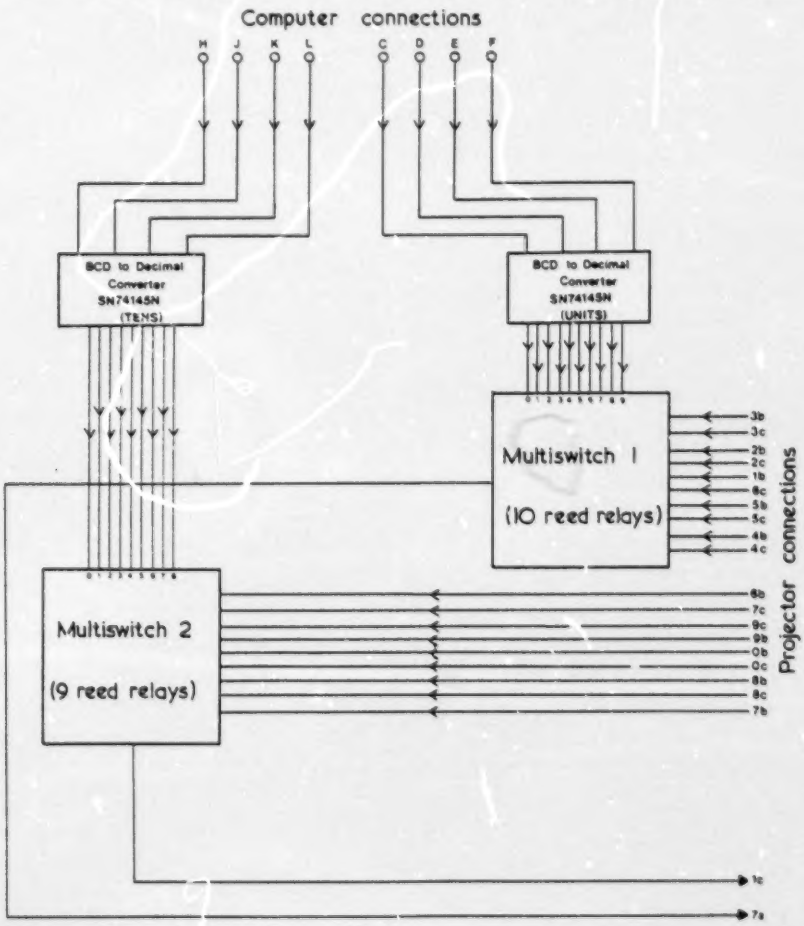


Fig. 3. Design of the Interface.

converter chip [4]. The output pins from each of these were connected to a multiway switch consisting of nine (or ten) Dual In Line reed relays [5]. These interconnections are shown in Fig. 3. The labelled wires entering the multiway switches from the right correspond to the connection points between the interface and the slide projector. In order to avoid confusion the labelling convention used corresponds exactly with that used in the manufacturer's circuit diagrams – this has been described previously.

Connections to the microcomputer are shown at the top of the diagram. Because the interface was developed in conjunction with a Commodore PET system the labelling convention (use of the letters H, J, K, L, C, D, E, F) corresponds with that used to represent the eight user-programmable pins associated with the User-port of the PET. Each of these pins may be set, under program control, for output (or input) of information using a suitable BASIC language initialisation instruction (of the form POKE 59459, X where $0 \leq X \leq 255$). A value of $X = 0$ sets all pins for input and a value $X = 255$ sets them up ready for output of information. Individual settings of pins (0 or 1 binary corresponding to signal levels of 0 and 5 volts, respectively) may be effected by the BASIC statement POKE 59471, X where $0 \leq X \leq 255$. A value of $X = 0$ sets all 8 pins to 0 volts while a value of $X = 255$ sets all pins to 5 volts. The voltage settings on the microcomputer output port pins are fed to the interface where they activate the multiway switches that were described above.

The construction of both of the multiway switches is identical. They each consist of an appropriate number of replications of the basic switching circuit (shown bounded by dotted lines) illustrated in Fig. 4. The BCD pattern input to the SN74145 chip determines which of its output pins is activated. The output voltages from the SN74145 are fed to a series of SN7404 hex inverter chips which perform signal inversion. The output from the inverter gate is passed to the base of a 2N3053 NPN transistor where it is used to turn on (or off) the collector to emitter current. The transistor switch is used to control a reed relay attached to its collector input pin. Pairs of relays (one in the tens multiswitch and one in the units

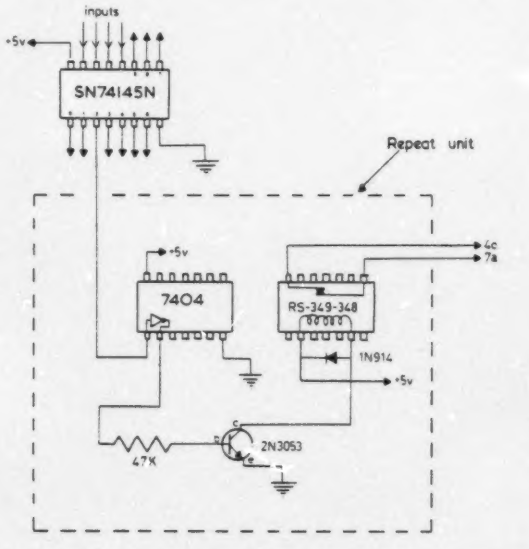


Fig. 4. Switching Element Circuit Details.

switch) operate synchronously to emulate the effect of the manual selector system.

Software control of the interface is a simple task. Any program that wishes to use it simply generates a bit pattern (8 bits) to represent two 4-bit BCD numbers that together represent a number in the range 0 through 80. This bit pattern is then passed across to the interface via appropriate 8-way cabling connections. Table 1 shows a control program that has been written in BASIC for the Commodore PET microcomputer. Statement 10 sets the data direction register of the PET user-

Table 1
Interface control program written in BASIC

```
  5  REM PROGRAM TO CONTROL RA SLIDE PROJECTOR
 10  POKE 59459,255 : REM SET DATA DIRECTION REGISTER
 20  INPUT "@£&&&&ENTER SLIDE NUMBER"; NS
 30  IF NS > 80 THEN 90
 40  IF NS < 0  THEN 90
 50  K = (INT(NS/10)*16) + NS – INT(NS/10)*10
 60  POKE 59471,K : REM ACTIVATE PROJECTOR
 70  GOTO 20
 90  PRINT "INVALID SLIDE NUMBER"
100  PRINT "TRY AGAIN"
105  K2 = TI
106  IF TI < K2 + 120 THEN 106
110  GOTO 20
```

port – all pins set for output. User input to the program via the keyboard is initiated by line 20. Validation of input responses from the user takes place in lines 30 and 40 with appropriate diagnostics generated by statements 90 through 106 if required. Provided a valid slide number is selected, statement 50 computes the required bit pattern to control the projector. This is passed across to the interface via statement 60. The program then loops back in order to service a further request from the user. Program termination can be achieved through an appropriate interrupt sequence generated by the RUN STOP key on the computer typewriter keyboard. Notice that in statement 20 use is made of special cursor control characters to produce dynamic graphic effects (in conjunction with the timing loop at statement 106) on the computer screen. These special cursor control characters are denoted in the INPUT statement by @ (clear the screen), £ (home the cursor) and & (cursor down one line).

The interface components fit conveniently into a box measuring $5.1 \times 8.4 \times 3.3$ (all dimensions in inches) fitted with 25-way (to the computer) and 37-way (to the projector) connectors. Power to drive the interface (a 5 volt supply) is taken from the microcomputer circuitry for convenience although an independent supply could be used if necessary. Several applications for the interface have been found. Some of these are described in Section 5 of the paper.

4. Limitations of the Interface

The design and construction of computer interfaces for random access projectors can be a difficult problem since they can place considerable demand on the I/O port of the host microcomputer. Thus, in the example described in the previous section each SN74145 IC has four input lines. Together, they require the use of all eight I/O lines of the microcomputer output port (a PET 6522 VIA). This is a severe limitation if other devices also need to use this for I/O.

Should the need arise to control a significant number of random access projectors then another limitation of the interface becomes apparent. For multiple projector control an appropriate addressing scheme would need to be introduced. The computer output port cannot be used because this is dedicated to the transfer of switch selection data. The microcomputer address bus, however, can be used to provide one solution to this problem. By equipping each projector with an address decoder/latch enable circuit it becomes possible to memory map the projectors onto the address space of the computer. The microcomputer output port could then be used as a common external data bus from which slide selection data is strobed by the projector whose identification is sent over the address bus. Alternatively, the microcomputer's internal bidirectional data bus could be used to transmit the slide selection data. Such an arrangement is illus-

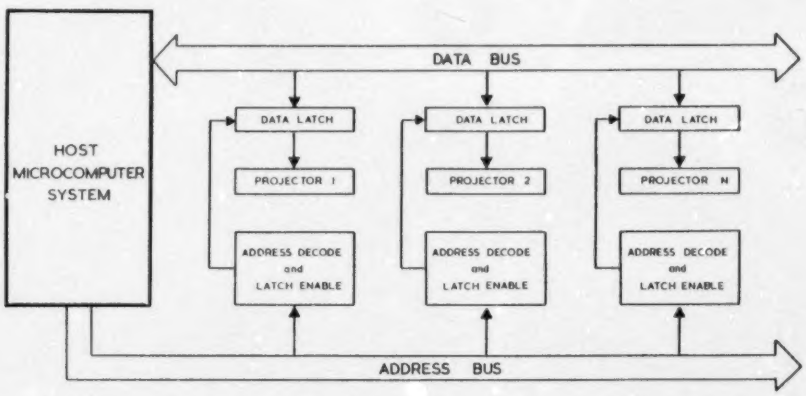


Fig. 5. Memory Mapped Random Access Slide Projectors.

trated schematically in Fig. 5. When using this approach to projector control, the BASIC statement POKE X, Y could be used to request that slide Y be displayed on the projector whose address is X. Memory mapping of projectors onto unused ROM addresses could thus be used to provide sufficient expansion capability to support any reasonable number of slide projectors.

5. Applications of the Interface

Many situations arise wherein it is necessary to gain random access to graphic data or visual images. For example, in many areas of experimental psychology subjects are confronted with randomly selected pictorial data and their responses then recorded. Similarly, in applications of computer assisted instruction (CAI) a student or trainee is presented with a visual image selected from a data bank [6] and is then asked to respond in some way. Based upon the results obtained by analysing the student's response, further images are then selected for presentation. Multi-media information retrieval and automated display systems are two further examples of situations that require random access to images. Some of these applications are discussed in more detail below.

5.1. Multi-Media CAI Systems

Suppose someone is to be trained in the use of microelectronics. Typically, under computer control a slide projector might be used to show the trainee some slides containing pictures of electronic components and circuit diagrams in which these are used. Subsequently, the computer would attempt to assess the trainee's understanding of the material by requesting the answer to a multiple choice question that it displays on its VDU screen. Assume that this has six single valued response options - say A, B, C, D, E and F. Once the student has responded to the question the computer may be required to execute the following type of decision logic:

If reply is A then show slide N;
If reply is E or C or B then show slide K;
If reply is D or F then show slide P;
If HELP requested then go to HELPER;
Go to INVALID-REPLY routine.

Obviously, to implement this kind of image presentation strategy in an effective way a random access slide projector is a necessary pre-requisite.

A multi-media CAI system has been designed and constructed. A description of this system has been given elsewhere [6, 7]. Instructional material is presented to students via three interaction channels - graphic images displayed on a slide projector, audio material presented on a tape recorder and textual messages displayed on the CRT screen of a microcomputer. These three main channels are supported by auxiliary ones based upon the use of conventional resources - a guidebook, printed notes, circuit diagrams, patch boards and so on.

In order to evaluate the capability of the system as a teaching aid at least two performance metrics need to be estimated. In [7], acceptability and effectiveness were choosen as the two important criteria. Acceptability refers to a host of different ergonomic, pedagogic and procedural factors that need to be analysed in conjunction with those who use the system - both authors (that is, teachers and instructors who prepare the instructional material) and learners (students and trainees who use the stored teaching material). The effectiveness metric is used to describe the utility of the system as a learning medium in relation to cost, time and effort. The important consideration here is whether the system imparts knowledge to the user. In other words, is the student more knowledgeable as a result of interaction with the teaching system? As pre-testing and post-testing are commonly used techniques for evaluating instructional schema and pedagogical strategies it was felt important to apply these methods to the evaluation of the multi-media instructional system outlined above. Further details on acceptability assessment of the system have been described by Yeates [7]. The remaining part of this case study briefly describes the method of using the random access slide projector and microcomputer to implement the pre-test and post-test used to assess the effectiveness of the CAI system.

The multi-media CAI machine used for instruc-

tion is equipped with a set of courseware units pertaining to some Universe of Discourse (UoD) that is to be presented to the student or trainee. Prior to any interaction with the teaching system the student is subject to a pre-test that is designed to assess his/her initial knowledge of the UoD. After interaction with the CAI system the student is asked to participate in a post-test in order to determine if his/her knowledge of the UoD has significantly increased. The experiments were conducted in the following way. A carousel of 80 slides was prepared. Each of the slides was related to the material contained in the courseware resident in the CAI machine. Appropriate human–machine dialogue programs were written to support these slides. A student could thus be shown a picture (in the form of a slide) and then asked a question(s) on the contents of the picture (via the CRT screen of the computer). The student is able to respond to the multiple choice question by means of conventional keyboard interaction, a light pen or a pressure sensitive keypad system [8]. All the CRT screen frames for the computer testing and the student response data are stored in a suitably designed data base system implemented on a flexible disk store facility.

The procedural strategy for the testing operations was as follows. A student would register at the computer keyboard and then be presented with a randomly selected sequence of 20 pictures and accompanying questions. The student's responses to the questions are recorded in the data base system. On completion of the pre-test the student proceeds to the CAI system where instruction takes place. Subsequently, the student sits a post-test in a similar manner to that described for the pre-test phase of the experiments. Having completed this, the results of each test are statistically compared in order to see if there is any significant increase in performance.

5.2. *Implementing Automatic Slide Display Systems*

An automatic slide display system is one which permits any given sequence of slides ($S_1, S_2, S_3 \ldots$) to be presented repetitively (say, N times). The system is described as automatic since once it has been programmed and activated there is no further need for any human intervention. During the presentation slides in the sequence may each be projected for a fixed length of time. Alternatively, the times for which particular slides are displayed may be individually specified.

Table 2 shows a BASIC control program that enables this type of automated display system to be set up. It runs on a Commodore PET microcomputer. When it is invoked the program requests its user to enter the number of repeats (R1), the number of images (S1) to be shown and the default display duration (D1). Once this data has been entered the user can specify the order in which slides are to be presented and the duration for which each is to be shown – if this does not correspond to the default value. This system (Commodore PET and Kodak S-RA2000 projector) has been used for a variety of automated demonstrations and advertising applications.

Table 2
Program for Automatic slide projection

```
100  DIM T(80), S(80)
110  POKE 59459,255
120  PRINT "□↓AUTOMATED SLIDE PROJECTION"
130  PRINT "••••••••••••••••••••••••••••"
140  INPUT "↓↓HOW MANY REPEATS"; R1
150  INPUT "↓↓HOW MANY IMAGES"; S1
160  INPUT "↓DEFAULT DURATION"; D1
170  FOR I=1 TO 80 : T(I) = D1 : NEXT I
180  PRINT "↓DO YOU WISH TO SPECIFY THE ORDER"
190  PRINT "IN WHICH SLIDES ARE PRESENTED?"
200  PRINT "↓→→→→→ANSWER Y OR N"
210  GET A$ : IF A$ = "" THEN 210
220  IF A$ = "Y" OR A$ = "N" THEN 240
230  GOTO 210
240  IF A$ = "Y" THEN GOTO 270
250  FOR I = 1 TO S1 : S(I) = I : NEXT I
260  GOTO 350
270  PRINT "↓↓ENTER THE SLIDE NUMBERS IN THE"
280  PRINT "SEQUENCE YOU WISH THEM TO BE DIS-
     PLAYED"
290  FOR I = 1 TO S1
300  PRINT "↓→→→→IMAGE"; I; "↑"
310  INPUT "→→→→→→→→→→→→WILL BE SLIDE"; S(I)
320  POKE 33637,32 : POKE 33638,32
330  PRINT "↑";
340  NEXT I
350  "□↓AUTOMATED SLIDE PROJECTION"
360  PRINT "••••••••••••••••••••••••••••"
370  PRINT "↓→→HOW MANY SLIDES DO NOT HAVE THE"
```

```
380  INPUT "→→DEFAULT DISPLAY TIME"; N
390  IF N = 0 THEN GOTO 500
400  PRINT "↓→→ENTER THE DETAILS BELOW:"
410  PRINT "↓↓"
420  FOR I = 1 TO N
430  INPUT "→→→→→IMAGE NUMBER:"; K1
440  INPUT "→→→→→DISPLAY TIME:"; K2
450  T(K1) = K2
460  POKE 33230,32 : POKE 33231,32
470  POKE 33270,32 : POKE 33271,32 : POKE 33272,32
480  PRINT "↑↑";
490  NEXT I
500  REM NOW CONVERT TIMES TO JIFFIES
510  REM AND CHECK FOR INVALID SLIDE NUMBERS
520  FOR I = 1 TO S1
530  T(I) = T(I)*60
540  IF S(I) < 0 OR S(I) > 80 THEN 760
550  NEXT I
560  REM NOW COMMENCE OPERATION
570  PRINT "□↓EXECUTION BEGINS"
580  FOR I = 1 TO R1
590  FOR J = 1 TO S1
600  GOSUB 670 : REM GET PICTURE
610  GOSUB 720 : REM INVOKE TIMER
620  NEXT J
630  NEXT I
640  NS = 0: GOSUB 690
650  PRINT "□↓↓EXECUTION TERMINATED"
660  STOP
670  REM ***RETRIEVE SLIDE
680  NS = S(J)
690  P = INT(NS/10)*16 + NS - INT(NS/10)*10
700  POKE 59471,P
710  RETURN
720  REM ***TIMER ROUTINE
730  K = TI
740  IF TI < K + T(J) THEN 740
750  RETURN
760  REM *** ERROR REPORT AND ABORT
770  PRINT "□↓↓↓***INVALID SLIDE NUMBER SPECIFIED"
780  PRINT "***EXECUTION NOT POSSIBLE"
790  PRINT "***RUN ABORTED"
800  STOP
```

5.2. *Implementing Graphic Interfaces to Information Systems*

Another area in which the random access slide projector has been utilised is in the design and implementation of pictorial interfaces to information retrieval systems. Very often, when a user of a computer system wishes to retrieve information from a data base he/she often knows what is wanted but is unable to express this requirement in 'words' or 'numbers'. However, if the user is presented with a sequence of pictures that describe the UoD covered by the data base being interrogated then it is possible (through an appropriate refinement dialogue) to retrieve the sought after information by means of simple menu selection techniques using a light pen, keyboard device or hand print terminal [9]. Graphic interfaces to information systems have been described by Senko [10]. Stonebraker [11] and others [12, 13]. Unfortunately, each of these implementations requires the use of expensive interactive graphics equipment. The microcomputer/slide projector technique, in contrast, offers a less expensive alternative that is useful in many situations that do not require full interactive grahics capability or sophisticated animation techniques. The remaining part of this paper describes the principle underlying graphic interfaces and how they may be implemented via multi-media human–machine interaction techniques.

The structured 'top-down' analytic decomposition of an entity into its component parts is an often used technique – sometimes referred to in dynamic situations as 'homing in'. It is a well established method of proceeding in gradual steps from a general view of an object to a highly magnified view of a specific part of that object. For example, in an anatomy lecture the student might be presented with a slide showing a general view of the human body followed by a close-up of the head. This, in turn, may be followed by a slide showing a section of the human eye and then another depicting the detail of the optic nerve. Thus, in a series of four slides the student is taken from a very general view of the human anatomy to a highly specific view of one of its sub-components. This principle and methodology can be used to significant advantage in the design of pictorial interfaces for information retrieval in a wide variety of contexts including computer assisted instruction. The principle is illustrated conceptually in Fig. 6.

This diagram shows several stepwise refinement stages in an information retrieval dialogue. The rectangle on the left of each set of diagrams represents the screen used for the presentation of images produced by the slide projector while that

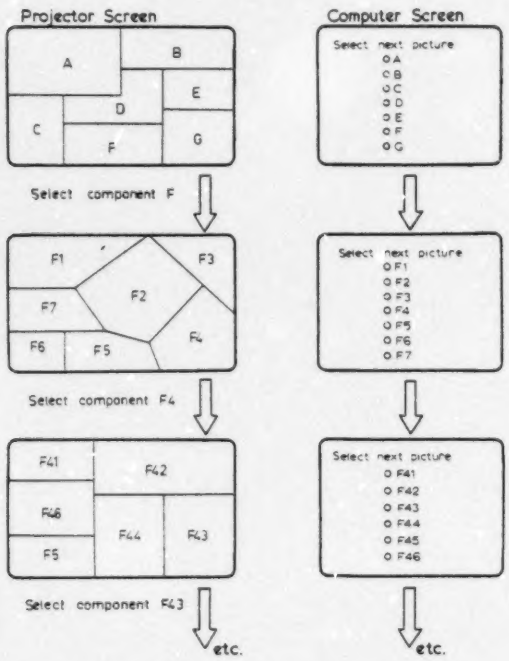


Fig. 6. Multi-Channel Stepwise Refinement.

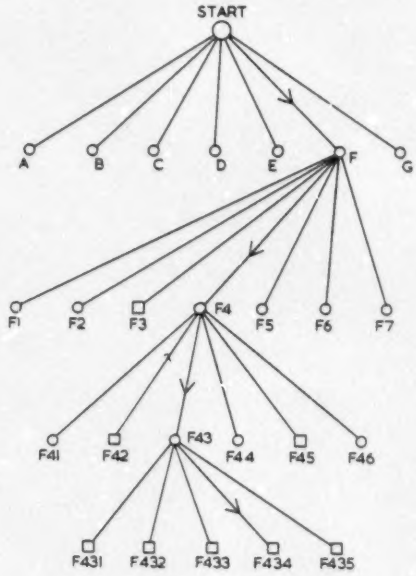


Fig. 7. Hierarchical Access Path.

on the right depicts the corresponding appearance of the text displayed on the CRT screen of the computer terminal or micro-computer. The topmost level represents the overall scope of the interface (or data base contents) in terms of the sub-pictures (or scenes) A through G. Selection of one of these sub-pictures (concept refinement) may be made either via light pen interaction with the computer screen or by means of some form of keypad or hand print terminal. The diagram shows selection of sub-picture F. A more detailed view of this component is now presented in terms of its sub-components (F1 through F7). Further interaction and selection may then take place until the required information bearing nodes of the hierarchical access path are encountered. These are shown as rectangles in the tree structure diagram presented in Fig. 7. Unfortunately, the storage capability of the slide projector used in this example seriously limits the complexity of the access tree (breadth and depth) since only 80 nodes are available. However, this restiction could easily be removed by employing extra projectors – according to the method described in Section 4.

An application of the principles outlined above has been described by Towne [14]. This system (called AIDE – Automated Instruction Direction and Exercise) has been used for training radar technicians. It depends upon random access to 125 images that are stored on 35 mm slides. The data base thus contains only enough slides to enable the system to be tested and evaluated. A more realistic data base is likely to contain about 1000 images of widely varying degrees of detail. Future developments of this system are directed towards increasing the capacity of the data base and adding a colour microfiche capability to enable more compact image storage. Similar milti-media information retrieval systems based upon the use of slides, microfiche and stored video images have been described by Stabletron [5].

6. Conclusion

A simple interface to enable the interconnection of a random access slide projector and microcomputer has been described. The use of the system to support milti-channel human–computer communi-

cation has been outlined in the context of some examples chosen from computer assisted instruction, automated display systems and information retrieval applications.

The interface is easy to use, inexpensive to construct and reliable. Its major limitation lies in the fact that it requires the availability of 8 I/O port lines to control it. This disadvantage could easily be overcome by using memory mapping techniques. No substantial modifications to the interface would be required if this approach was adopted.

References

[1] C.W.H. Erickson and D.H. Curl, Fundamentals of Teaching with Audiovisual Technology (Macmillan, New York, 2nd ed., 1972).

[2] Kodak Limited, Kodak Carousel S-RA2000 Slide Projector Manual. Publ. No. 0-96312-478, West Germany (1980).

[3] Commodore Business Machines Limited, CBM PET 3032N Professional Computer Users' Manual, Publ. No. 320856-3 (June 1979).

[4] Texas Instruments Limited, The TTL Data Book for Design Engineers, Publ. No. LCC4112, 4th ed. (1980).

[5] R.S. Components Limited, 13–17 Epworth Street, London, EC2P 2HA, Electronic Components Catalogue (1980/81).

[6] P.G. Barker and H. Yeates, Problems associated with multimedia data base systems, in: L.P. Grayson and J.M. Biedenbach, Eds., Frontiers in Education – Proceedings of the 10th ASEE/IEEE Conference, Houston, Texas, 20–22 October 1980, Institute of Electrical and Electronics Engineers (1980) pp. 331–344.

[7] H. Yeates, Some experiments in man–machine interaction relevant to computer assisted learning, MSc Thesis, University of Durham, Durham (1981).

[8] P.G. Barker, A CAI interface for the disabled, Interactive Systems Research Group Working Paper, Teesside Polytechnic, United Kingdom (1982).

[9] P.G. Barker, Data base interaction using a hand print terminal, International Journal of Man-Machine Studies (1982) in press.

[10] M.E. Senko, DIAM II with FORAL LP: Making structured queries with a light pen, IBM Thomas J. Watson Research Centre, Yorktown Heights, NY, Research Project RC 6034, No. 26141 (1976).

[11] M.R. Stonebraker and N. McDonald, CUPID – The friendly query language, Paper presented at the 16th IFIP/IAG Data Base Workshop, Brussels (December 1975).

[12] P.G. Barker and P.S. Jones, Syntactic definition and parsing of molecular formulae, Part 2: Graphical synthesis of molecular formulae for data base queries, Computer Journal 21(3) (1978) 224–233.

[13] Various papers in: Proceedings of the 1980 IEEE Workshop on Picture Data Description and Management, IEEE Computer Society, Publ. No. 80CH1530-5 (August 1980).

[14] D.M. Towne, The automated integration of training and aiding information for the operator/technician, in: W. King, Ed., Proceedings of the Third Biennial Conference on Maintenance Training and Aiding, Orlando, FL (1979), pp. 53–63.

[15] Stabletron Limited, 266 Hunts Pond Road, Titchfield Common, Fareham, Hampshire, PO14 4PH, Stabletron Information Retrieval Systems and Opto-Mechanical Electronics (January 1980).

Philip Barker is a Principal Lecturer in the Department of Computer Science at Teesside Polytechnic. He is a graduate of the University of Wales and is a member of the ACM and IEEE. His research interests lie in the area of human–machine interaction. He has undertaken a number of studies of the user interface with computer systems. The research topics in which he is currently interested include: author languages for computer assisted instruction (CAI), applications of CAI to the problems of the disabled, query languages for data base systems, intelligent interfaces and image processing for videodisk systems.